

VERSION WITH MARKINGS TO SHOW CHANGES MADE

58. (twice amended) A Chemical-Mechanical Polishing (CMP) method for polishing Ta barrier layers in integrated circuit metallization structures including copper and silica, said method including flowing polishing slurry containing silica abrasive, DI water, and a copper passivation agent, onto a platen, inducing relative motion between said wafer and said platen and maintaining a force between said platen and said wafer, and removing said wafer from against said platen, said polishing occurring for a total polishing period of time, comprising,

incorporating into said polishing slurry for a final portion of said total polishing period of time less than or equal to 10% of said total polishing period of time, an organic additive selected from the group consisting of:

polyvinyl alcohol (PVA), PVA-poly(vinyl acetate) co-polymer, PVA-polyethylene co-polymer, sorbitol, glycerol, polyacrylamide (PAA), ethylene glycol, di(ethylene glycol), poly(ethylene glycol) (PEG), glycerol ethoxylate (GEO), dimethylsiloxane-ethylene oxide co-polymer (DMSiO-EO), polyethylene oxide surfactants, octylphenol polyethylene oxide, nonylphenol polyethylene oxide, polyoxyethylene lauryl ether, polyoxyethylene cetyl ether, perfluorinated analogs of polyethylene oxide surfactants, glycerol propoxylate (GPO), organic amines, N,N-diethylcyclohexylamine (DCA), and polyethyleneimine (PEI);

said organic additive not being included in said polishing slurry prior to said final portion of said total polishing period of time.

63. (twice amended) In a Chemical-Mechanical Polishing (CMP) method for polishing Ta barrier layers in integrated circuit metallization structures including

copper and silica, said method including flowing polishing slurry containing silica abrasive, DI water, and a copper passivation agent onto a platen, inducing relative motion between said wafer and said platen while maintaining a force between said platen and said wafer, and removing said wafer from against said platen, said polishing occurring for a first polishing period of time, the improvement comprising:

decreasing said flow of said polishing slurry prior to said step of removing said wafer from against said platen; and

following said step of decreasing said flow of said polishing slurry and prior to said step of removing said wafer from against said platen, flowing a polishing additive solution onto said platen for a second period of time while inducing relative motion between said wafer and said platen and maintaining a force between said platen and said wafer;

said polishing additive solution comprising;

DI water;

a copper passivation agent selected from the group consisting of,

1,2,4-triazole, benzotriazole (BTA), imidazole, 5-methyl benzimidazole, polyaniline, indazole, and purine; and

an organic additive selected from the group consisting of,

polyvinyl alcohol (PVA), PVA-poly(vinyl acetate) co-polymer,

PVA-polyethylene co-polymer, sorbitol, glycerol,

polyacrylamide (PAA), ethylene glycol, di(ethylene glycol),

poly(ethylene glycol) (PEG), glycerol ethoxylate (GEO),

dimethylsiloxane-ethylene oxide co-polymer (DMSiO-EO),

polyethylene oxide surfactants, octylphenol polyethylene

oxide, nonylphenol polyethylene oxide, polyoxyethylene lauryl

ether, polyoxyethylene cetyl ether, perfluorinated analogs of polyethylene oxide surfactants, glycerol propoxylate (GPO), organic amines, N,N-diethylcyclohexylamine (DCA), and polyethyleneimine (PEI);

said polishing slurry not including said organic additive prior to said step of flowing said polishing additive solution.

REMARKS

Claims 58-61 and 63-73 remain in the application.

35 USC 102 rejections

The Examiner has rejected claim 58 as being anticipated by Uzoh. Applicant respectfully traverses this rejection. The Examiner states that Uzoh's polishing slurry and method read on the claimed invention. Applicant has amended claim 58 to further clarify that in the instant invention the organic additive is only included into the slurry for the final portion of the polish process comprising no more than 10% of the total polish time. In contrast, in the Uzoh method, the organic additive (i.e., the surfactant Alkanol) is included in the slurry throughout the entire polish time. Applicant respectfully but strongly asserts that the Uzoh method does not anticipate the present invention as claimed. Applicant therefore respectfully requests that the 35 USC 102 rejection be withdrawn.

35 USC 103 rejections

The Examiner has rejected claims 59-61 under 35 USC 103(a) as being unpatentable over Uzoh. Applicant respectfully traverses these rejections and requests reconsideration.

The Examiner's reasoning for the rejection of claims 59 – 60 are the same as those for claim 58, as well as asserting that the specific concentrations cited in claim 61 are routine optimization. In doing so, the Examiner has failed to properly consider the inventive steps cited in claims 58 and 59, which involve using a two-step polishing process by having the organic additive included in the CMP slurry

only at the very end of the polishing sequence. This two-step polishing sequence has been developed as a method to minimize clogging of filters in the polisher (as stated in the specification, page 31, line 25), and to prevent copper staining and precipitates onto the wafer. There is no recognition by the Uzoh reference of any staining, precipitation, or clogging problems associated with the use of an organic additive during the entire polishing process, and Uzoh's process includes the Alkanol surfactant during the entire polishing period. Thus Uzoh teaches away from the two-step polishing process claimed in the present invention.

The Examiner has clearly not established a *prima facie* case for obviousness. Applicant respectfully requests that the rejections be withdrawn.

The Examiner has rejected claims 63 – 73 under 35 USC 103 as being unpatentable over Uzoh in view of Murphy et al. Applicant respectfully traverses these rejections.

The process claimed in claim 63 is a two step process whereby during the first period of time the abrasive-containing slurry without the organic additive is used to polish the wafer, and during the second period of time the slurry flow is decreased while the polishing additive solution including the organic additive is flowed to prevent or remove any copper staining or precipitates, while not clogging the filters. Claim 63 has been amended to clarify that the organic additive is not included prior to the flowing of the polishing additive solution. There is no recognition by Uzoh of any problems associated with the use of an organic additive during the entire polishing process, and Uzoh's process includes the Alkanol surfactant during the entire polishing period. Thus Uzoh teaches away from the two-step polishing process claimed in the present invention.

Accordingly, Applicant respectfully requests that the rejection of claim 63 be withdrawn.

Claims 64-73 depend on claim 63 and claim specific process step orders, flow rates, and concentrations. Examiner asserts that “conducting routine experimentation for the purpose of reducing damage to the workpiece would optimize the selection of particular values for these variables”. As described above, the Examiner fails to take into account that the flowing of the organic polishing additive solution at the end of the polishing process is utilized to prevent copper staining and precipitates and equipment clogging. The Applicant’s motivation is not associated with a decrease in mechanical damage to the workpiece.

Examiner further asserts that “it would have been obvious to modify Uzoh... Murphy’s point of use mixing...for the purpose of providing substantial cost and time reduction in the use of slurries...”. Point-of use mixing as in Murphy is known in the art. However, the improvement of claim 63 is neither taught nor implied by Uzoh, alone or in combination with Murphy. In the present invention, the flowing of the organic polishing additive solution at the end of the polishing process is utilized to prevent copper staining and precipitates and equipment clogging. The Applicant’s motivation is not associated with cost and time reduction.

The process claimed in claims 64-73 is a two step process whereby during the first period of time the abrasive-containing slurry without the organic additive is used to polish the wafer, and during the second period of time the slurry flow is decreased while the polishing additive solution including an organic additive is flowed to prevent or remove any copper staining or precipitates, while not clogging the filters. There is no recognition by Uzoh or Murphy of any problems

associated with the use of an organic additive during the entire polishing process, and Uzoh's process includes the Alkanol surfactant during the entire polishing period. Thus Uzoh teaches away from the two-step polishing process claimed in the present invention. Accordingly, Applicant respectfully requests that the rejection of claims 64-73 be withdrawn.

Applicant has made a diligent attempt to address all of the Examiner's points. It is believed that the application is now in condition for allowance. An early Notice is requested.

Respectfully submitted,



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